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crabs, empty shells of sea-urchins, and oftentimes many objects that are really worth preserving for cabinet specimens.

EXPLANATION OF PLATE 6.

- Fig. 1. Common Barnacles, *Balanus eburneus* of Gould.
 Fig. 2. " " " *ovularis* "
 Fig. 3. Free swimming young of Barnacle.
 Fig. 3a. Young Barnacle directly after attachment.
 Fig. 4. Sea-anemone expanded, *Metridium marginatum*.
 Fig. 5. " contracted,
 Figs. 6, 7. Periwinkle, *Littorina palliata*.
 Figs. 8, 9. Cockle, *Purpura lapillus*.
 Fig. 9a. Egg-cases of the same.
 Fig. 10. Mussel, *Mytilus edulis*.
 Fig. 11. Starfish, *Asterias vulgaris*.
 Fig. 12. Brittle Starfish, *Ophiopholis bellis*.
 Fig. 13. Hermit-crab, *Bernhardus longicarpus*.
 Fig. 14. *Spirorbis nautiloides*.

OUR SEA-ANEMONES.

BY A. E. VERRILL.

To all frequenters of the sea-shore during the summer months who take pleasure in seeking and studying the many wonderful and beautiful inhabitants of the ocean, the modest and retiring Sea-anemones cannot fail to offer many attractions; and there are few marine creatures that can so easily be reconciled to the narrow limits of an aquarium, and so readily become permanently established in their new home. Thus they afford us every opportunity to study their habits and structure, and to watch their ever-varying forms and beautiful colors. But to see them in their perfection one must visit them in their native haunts in some cool, rocky pool, overhung with projecting ledges and drooping seaweeds, or in some deep grotto among the shattered cliffs, half-illuminated by the sunbeams which struggle for entrance

through the cool sea-weeds that hang from the rocky roof dripping with salt dew. In such favorite retreats the *Fringed Sea-anemones** (Plate 6, figs. 4, 5) make their home and rear their numerous families, year after year, until every nook and crevice is fully occupied, and even the entire floor is completely carpeted by their soft, delicate tufts of tentacles. In such localities it is common to see specimens of every variety of hue, from pure white, pink, salmon, chestnut, orange, yellow, and light-brown, to dark-umber; while others will be mottled or variously striped with two or more colors. These colors, however, are those of the outer wall of the body. But the upper part of the body and the innumerable tentacles have lighter and more delicate tints, and this, combined with their translucent texture, gives to the summit of the body and its broad crown of fine tentacles a peculiarly graceful appearance, which is much increased by the numerous deep frills into which the tentacle-crowned margin of the disk is always thrown in the*large specimens. The tentacles are also frequently banded with white. It is always difficult to decide which specimen in one of these numerous colonies is most beautiful when all are so attractive. But the pure white ones most frequently suffer for their beauty, and are borne away in triumph to new homes, which, perchance, prove in the end less happy and pleasant to them than the home of their youth.

The Fringed Sea-anemone is not found exclusively in such places as described, but may be found on almost any rocky or ledgy shore along the coast of New England, and in fact from New York to Labrador, snugly ensconced in the crevices between boulders, or on their under surfaces, wherever there is sufficient space to expand their tentacles, and complete shade from the sun's heat. For although these lowly

* *Metridium marginatum* Edw. and H. For a more complete description, see "A Revision of the Polyps of the Eastern Coast of the United States," by A. E. Verrill, in *Memoirs of the Boston Society of Natural History*, Vol. I. For other descriptions and figures, see "Sea-side Studies in Natural History," by E. C. and A. Agassiz, and Tenney's *Zoölogy*.

organized creatures have no eyes, nor even nerves, they are very sensitive to strong light, and love the shade. They may also, at times, be found clinging to the piles of wharves, and on small stones and shells, wholly unprotected. Near Mount Desert Island, I once saw, during a very low tide, a large surface of rocky bottom so completely covered by them, that the foot could not be put down without crushing many noble specimens. A single stone, the size of a man's head, taken from this place, was found to be the residence of sixty individuals, of all sizes. They sometimes occur at a greater depth than twenty-five fathoms, but are frequently found between high and low-water mark, both in pools and in places where they are left dry for an hour or more, where they hang relaxed and flabby until the tide returns, when they quickly revive. To remove large specimens of this species from their favorite rock, without serious injury, is no easy matter; for although they are not permanently attached, but are capable of moving freely about by gliding along upon their large, highly muscular, adhesive base, yet when disturbed they cling so closely and firmly to the rock, that they are very liable to be torn open upon the base, rather than loosen their hold. But if the rock be tolerably smooth, by gradually and carefully starting them up by pushing with the thumb-nail or some dull instrument against and under the base, they may finally be safely removed. If broken open they will never recover or heal, though they will usually expand and appear very well for several days.

In the confinement of an aquarium, or even in a jar or bowl of sea-water, one of these Actinias will soon make itself at home, and, fixing itself upon one side of the vessel by its base, will expand its feathery plume of tentacles day after day in search of tiny prey, and woe to the unlucky creature, be it animalcule, shell-fish, shrimp, or fish, that comes in contact with its crown of gorgon-tentacles, armed with myriads of poison-darts, deadly to all creatures destined to be its prey! When fully expanded, this species has

a very graceful form, which cannot fail to please any one who has a taste for the symmetry and beauty of natural objects. From the slightly expanded base the body arises in the form of a tall, smooth column, sometimes cylindrical, sometimes tapering slightly to the middle, and then enlarging to the summit. Towards the top the column is surrounded by a circular, thickened fold, above which the character of the surface suddenly changes, the skin becoming thinner and translucent, so that the internal radiating partitions are visible through it. This part expands upward toward the margin, which is folded into several deep undulations or frills, and these edges are covered everywhere by an immense number of fine, slender, crowded tentacles, which also occupy about half the width of the oral disk, but increase in size and diminish in number toward the mouth, which occupies the centre of the disk. The mouth is oval, and its lips have numerous folds. It opens directly into the stomach, which is a simple sac suspended in the centre of the body, having a small opening in its lower end, through which the products of digestion are poured into the main cavity of the body, while the hard or undigested parts of the food, such as shells, bones, etc., are cast out from the mouth. The whole interior of the body, between the stomach and exterior, is divided up into an immense number of narrow chambers, by thin muscular partitions, which radiate from the centre toward the exterior, and are of various widths, some reaching from the wall to the stomach and serving to support it, while others extend only a little way inward from the outer wall; each tentacle is hollow and is a direct continuation of the radiating chamber below it, so that there are as many chambers as tentacles, and, of course, twice as many radiating partitions as chambers. The digested food, mingled with sea-water, serves for blood, and fills all the chambers and the main cavity of the body below the stomach; and, as there is no heart, this fluid is put in motion and circulated through every part by means of

myriads of minute vibrating lashes, or *cilia*, that cover all parts of the interior surface, and this same surface of soft membrane has the power of absorbing such nutritious substances as each organ may require, from the fluid that bathes it, and also the oxygen contained in the sea-water. Indeed it is probable that every part of the surface, both external and internal, has the power of absorbing oxygen; but it is reasonable to conclude, that this takes place most rapidly in the tentacles and internal membranes where the structure is most delicate.

We usually notice, when trying to remove one of these Actinias from its rock, a large number of white, thread-like organs, emerging both from the mouth and from minute openings through the sides of the body. These organs appear to be for the defence of the creature, since they are found to be composed almost entirely of minute poison-darts, or lasso-cells, arranged side by side, and having a deadly stinging power when used against small animals. In fact there are very few of the predacious marine animals, even not excepting the voracious fishes, that have the temerity to attack one of the harmless-looking Sea-anemones; for though their darts may not have sufficient power to kill a large fish, they will, at least, penetrate the thin membranes of the mouth and produce a severe stinging, like that of nettles. And since these stinging threads may be thrown out copiously, and are several inches long, they are very effectual organs of defence. The inner ends of the threads are attached to the free edges of the radiating partitions, and the free ends are thrown out simply by the contractions of the animal, and consequent expulsion of the fluid contained in its body, which, as it rushes out of the mouth and through the loop-holes of the sides, carries with it the threads. When the Actinia is again left in repose, it gradually draws in its stinging threads. The little poison-darts, usually called lasso-cells, which cover both these threads and the tentacles, have a wonderful structure for organs so minute. They

consist of little vesicles or cells filled with fluid, and have a very long, extremely thin tube, coiled up in the interior. This tube is continuous with one end of the vesicle that contains it, so that when the vesicle is compressed or contracted the fluid forces out the tubular dart by turning it inside out, as one would turn the finger of a glove. The slender tube, when thrust out, is very long, slender, and pointed, and usually curiously and wonderfully barbed. The nature of the poison, so deadly to small animals, which these darts emit when they penetrate the flesh, is still unknown; but whatever its nature, it must be very powerful, for the quantity is necessarily excessively small. The tentacles not only capture and kill the prey by means of these organs, but by means of the darts, that thus penetrate in large numbers, they hold it firmly until conveyed from the tentacles to the mouth. Among our native Sea-anemones there are no species that have darts powerful enough to sting the hand, though some species, like the Star-anemone, will often adhere so firmly, if its tentacles be touched by the finger, that it may be lifted from the water before it will loosen its hold. This adherence is doubtless due to the many lasso-cells that partially penetrate the epidermis, or outer layer of the skin, but have not power to enter far enough to reach the sensitive portion. But the common, large, red Jelly-fish (*Cyanea arctica*) has similar poison-darts covering its long, floating, thread-like tentacles, which are powerful enough to penetrate the human skin, and sting far more painfully than nettles. And among the coral reefs of Florida and the West Indies, there are corals (*Millepora*) which, unlike most corals, have animals belonging to the same class with the Jelly-fishes, and their tentacles have poison-darts, which, according to the observations of Professor Hartt, sting the parts of the hands where the skin is most delicate very severely. The same is true of some other *Hydroids*, which do not form coral, but grow in moss-like tufts. It is also said that some of the foreign Sea-anemones have the same power of stinging

the hands, and especially those of persons having a delicate skin. But certainly no such charge has ever been brought against any of our native species.

The Fringed-anemone makes a very pleasing pet in confinement, and, if allowed plenty of room and fresh sea-water, will expand almost constantly. It feeds readily upon the flesh of all sorts of shell-fish, etc., and will not refuse bits of raw beef. And if necessity compels, it will live for months, or even a year, without food; but, curiously enough, it will continually grow smaller and smaller, so that a specimen, at first five or six inches high and two in diameter, may thus be reduced to the height of an inch, and the diameter of less than half an inch, the number of tentacles and chambers being proportionately reduced. In fact, under such circumstances, the animal seems to undergo a retrograde process, exactly the reverse of that by which it originally developed from youth to maturity.

The ovaries of Actinias, and all similar animals, including the coral-polyps, are attached to the inner edges of the radiating partitions below the stomach, and are filled with immense numbers of eggs, which are discharged, when mature, directly into the fluid filling the body, and then are either discharged very soon from the mouth, or are retained for a longer or shorter time, until they are hatched into miniature Actinias, which are discharged in different stages of development and of various sizes; but however small they may be, they are perfectly competent to take care of themselves from the first. The Fringed-anemone, and some other kinds, when they remove from places where they have long been stationary, are liable to tear off and leave behind them little fragments from the edge of the base, but every one of these fragments will in a few days develop a little mouth and a row of tentacles around it, and will soon become a perfect little Actinia, differing only in size from its parent. The same effect may be obtained at will by cutting off little portions from the edge of the base with a sharp knife. This

process is evidently analogous to the wonderful powers of restoration and development of mutilated and lost parts, so well known by experiments upon the fresh-water *Hydra* and other low animals, some of which may be cut up in every direction into many pieces, and each part will still restore all the parts that are lacking. It has, also, some analogy to the process of budding, so common among the coral-polyps.

The *Star Sea-anemone** is another beautiful and interesting species, which may readily be domesticated in an aquarium, and proves very hardy in confinement. This species, instead of having a smooth body like the preceding, is covered with little wart-like pustules, arranged in vertical rows, which have the power of adhering firmly to foreign substances, such as bits of shell and sea-weed, with which it often so completely covers its body as to effectually conceal itself, when contracted into a low cone among the rocks and gravel where it often dwells. But when it lives, as it frequently does near Eastport and about the rocky shores of the neighboring islands in the Bay of Fundy, in fissures and cavities of ledges, overhung and protected by sea-weed, it usually discards its foreign covering, which now becoming no longer useful, is evidently regarded as a burden. When placed in an aquarium, even if covered with foreign matters, it very soon discards them and appears perfectly clean. The uppermost pustule of each row is larger than the others, and forms an inflated vesicle just below each tentacle. The tentacles, instead of being very small and numerous, as in the Fringed-anemone, are comparatively few, rarely more than seventy-two in the largest specimens, but they are large and often more than an inch long. The mouth usually has the form of a cross, with several prominent folds upon its lips. Its body is usually pale, translucent, olive-green, sometimes approaching flesh-color, and the disk and tentacles have a lighter tint of the same colors, while the tentacles are con-

* *Bunodes stella* Verrill. Memoirs of the Boston Society of Natural History, Vol. I, p. 16, Plate I, figs. 1 to 8. Also a figure copied in Tenney's Zoölogy.

spicuously banded with opaque-white, and upon the disk there are usually six or twelve white lines, radiating from the mouth to the bases of the tentacles. Most of the tentacles usually have a white, heart-shaped spot upon the inner side of their bases. This pretty Actinia is very common at Eastport and vicinity, and has been found at Cape Elizabeth, Maine. In the latter locality the specimens were half-buried in sand at the bottom of a rocky pool near low-water mark. Doubtless it will be found upon all parts of the rocky coast of Maine. In confinement it expands most freely in the evening. It feeds, like the other species, upon all sorts of mollusca and crustacea that come within its reach. It brings forth living young, often of considerable size, which emerge at irregular intervals from the mouth, sometimes singly, sometimes in large numbers. It does not grow so large as the preceding, the body seldom becoming more than two inches high and one in diameter, but having more than twice that diameter across the expanded tentacles.

The *Red Sea-anemone** is unquestionably the most beautifully colored and showy of all our northern Actinias; but, although very changeable in shape, it lacks the elegant forms assumed by other species. The body usually forms, in expansion, a low cylinder, broader than high, with a broad disk, surrounded by a moderate number of large, rather short, tapering or blunt tentacles. The exterior of the body is sometimes nearly smooth, but at other times shows a few, rather inconspicuous, warts or suckers scattered over the surface. The colors are extremely variable. The shore specimens are mostly irregularly mottled with deep brownish red, and dull greenish, while the tentacles are pinkish, banded with opaque-white. The disk is often light-greenish or pink, with radiating lines of purple or

* *Rhodactinia Davisii* Agassiz. For full descriptions see the Memoirs Boston Society above quoted, and for a figure, "Sea-side Studies," p. 13, fig. 10. This species belongs to the "sub-genus" *Urticina* of Ehrenberg, and as that is an earlier name, it should be called *Urticina Davisii*, until it be settled whether it be really distinct from *U. crassicornis* of Europe.

deep red, which embrace the bases of the tentacles. Occasionally shore specimens are found having the body uniformly bright red, crimson, or pink, with a lighter-colored disk and tentacles. The tentacles are usually banded with white in all varieties, but are sometimes uniform pink and translucent. Other specimens often have the body pink, mottled with orange-red, or blotched with crimson. The specimens from deep water have generally brighter and clearer colors than those of the shore, but are quite as commonly found mottled with two or more shades of red, as of uniform red or pink colors. The habits of this fine *Actinia* are much like those of the last, and the young are produced in the same manner. It attains a much greater size, for specimens are not uncommon which are two inches high and four or five in diameter when expanded. The large specimens, however, are apt to be troublesome inmates of an aquarium, on account of their remarkable voracity, for nothing seems to come amiss to them. They will capture and swallow fishes of considerable size, as well as crabs, mollusks, etc., and even have been known to swallow the spiny sea-urchins of considerable size. Other *Actinias*, even, are not safe in their neighborhood. Such large specimens also have a singular habit of frequently protruding the stomach, and even turning it wrong side out, as if affected with nausea, which certainly adds nothing to their beauty. But specimens of small or medium sizes make very interesting pets, and are often more beautifully colored than the large ones.

In Massachusetts Bay this species is seldom found except by dredging, when it usually comes up adhering to stones and dead shells. It inhabits all depths down to forty fathoms at least. At Eastport, Grand Menan, and other islands at the mouth of the Bay of Fundy, where the enormous tides leave exposed, at low-water, a wide zone, unusual facilities are afforded for obtaining all sorts of rare and curious marine productions, which, on other parts of the coast, can be

obtained only by dredging in deep water. On these shores the two large *Solasters*, or Starfishes, with ten or twelve rays and beautiful colors, together with several other rare Starfishes, the Daisy Serpent Star,* the many-armed Basket Fish,† several large and curious Holothurians, the elegant Alcyonium, the much-sought Terebratula, many curious and beautiful Ascidians, among which the Cynthia,‡ or "Sea Peach," is one of the finest, and a great variety of rare shells, may all be obtained at low-water, during the extreme tides, together with a great abundance of the three Actinias above described. The Red, like the Star Sea-anemone, loves best the fissures and crevices of the rocks and ledges, that are thickly overgrown with fuci and other sea-weeds, which furnish a complete protection to the animals nestling among the rocks. Even among the lofty wharves of East-port there are ledges in the crevices of which hundreds of these Anemones may be found.

The *White-armed Sea-anemone*,§ unlike the three preceding species, is as yet unknown except along the southern coasts of New England, upon the shores of Long Island Sound, and near New York City. This Actinia is more nearly related to the Fringed-anemone than to the others, and like that has slender tentacles, and loop-holes along the sides of the body, out of which threads of stinging darts issue, which are lacking in the two last species. But this is a smaller and more delicate kind, seldom growing more than three inches high and one in diameter, and the tentacles are much longer and not so numerous. The body is of the same texture from base to summit, and the edge of the disk is not thrown into undulations, or "frilled." Its colors are usually light-yellowish, or flesh-colored, and translucent, while the tentacles are usually white. It lives most commonly at-

* *Ophiopholis bellis* Lyman. Plate 6, fig. 12.

† *Astrophyton Agassizii* Stimpson.

‡ *Cynthia pyriformis* Rathke.

§ *Sagartia leucolena* Verrill. Proceedings of Boston Society of Natural History, Vol. X, p. 336. 1866.

tached to the under side of boulders that have a cavity beneath them, and is well adapted to the aquarium, where it very soon becomes perfectly at home, and expands almost constantly. Inhabiting the same region with this there is another more rare species of *Sagartia*,* which is duller in color and less graceful in form, which lives buried up to its tentacles in gravel.

Besides the species already described, there are several others that are less conspicuous, which inhabit the New England coast, several of which live buried in sand or mud, like many worms, and only protrude their tentacles at the surface. These kinds are usually long and slender, and taper at the base instead of having a flat adhesive disk. Farther southward on the Carolina coast there are several other peculiar species, some of them beautifully colored, and also several species of true corals, the animals of which closely resemble the Sea-anemones in structure and habits. One pretty species of coral† is even found on the southern coast of New England. This is found just below low-water mark, encrusting stones and shells, and forming little irregular masses of coral, covered with star-like cells or cups, which are about an eighth of an inch across. The polyps, which in life rise above these stellate cups, are colorless and almost transparent, resembling, in nearly all respects, miniature *Actinias*. This coral lives well in confinement, and feeds readily upon bits of oyster, in the same manner as the Sea-anemones.

THE MARINE AQUARIUM.

BUY at any glass-shop a cylindrical glass jar, some six inches in diameter and ten high, which will cost you from three to four shillings; wash it clean, and fill it with clean

* *Sagartia modesta* Verrill. Described with the preceding species.

† *Astrangia Danæ* Agassiz.